CLAIMS

What is claimed is:

1. An electrode assembly for electroporation of a tissue surface, comprising:

a non-conductive carrier having a proximal surface, a distal surface, and a plurality of through holes from the proximal surface to the distal surface;

a plurality of first electrodes disposed on the proximal surface;

a first conductor disposed on at least a first portion of the distal surface and extending through at least a first portion of the plurality of through holes and connected to the first electrodes on the proximal surface;

a plurality of second electrodes disposed on the proximal surface; and

a second conductor disposed on at least a second portion of the distal surface and extending through at least a second portion of the plurality of through holes and connected to the second electrodes on the proximal surface;

wherein the first electrodes are in closely spaced relation with the second electrodes on the proximal surface for engaging the tissue surface and applying an electric field.

2. The electrode assembly according to claim 1 wherein the carrier comprises a thin flexible film.

3. The electrode assembly according to claim 2 wherein each electrode is surrounded by at least one electrode of an opposite polarity.

4. The electrode assembly according to claim 3 wherein one of said electrodes is a center electrode and another electrode is a ring electrode surrounding said one electrode..

5. The electrode assembly according to claim 4 wherein said electrodes are disposed in a grid pattern.

6. The electrode assembly according to claim 3 wherein said electrodes are substantially square in configuration wherein said electrodes are circular in configuration.

7. The electrode assembly according to claim 6 wherein said electrodes are disposed in a grid pattern.

8. The electrode assembly according to claim 3 wherein said electrodes are concentrically disposed of alternate polarity.

9. The electrode assembly according to claim 8 wherein said electrodes are disposed in multiple alternate rows of different numbers.

10. The electrode assembly according to claim 1 comprising a fluid reservoir on said distal surface of said non-conductive carrier in communication with said plurality of through holes for conveying fluid to the surface of said electrodes.

11. The electrode assembly according to claim 1 further comprising an insulating barrier that is disposed on at least a third portion of the proximal surface of the carrier between the first electrodes and the second electrodes and projecting above the surface of the electrodes.

12. An apparatus for trans-surface molecular delivery, comprising:

a first electrode assembly, comprising:

a non-conductive carrier having a proximal surface, a distal surface, and a plurality of through holes from the proximal surface to the distal surface;

a plurality of first electrodes disposed on at least a first portion of the proximal surface;

a first conductor disposed on said distal surface and extending through at least a first portion of the plurality of through holes and connected to the plurality of first electrodes; and

a plurality of second electrodes disposed on at least a second portion of the of the proximal surface;

a second conductor disposed on said distal surface and extending through at least a second portion of the plurality of through holes and connected to the plurality of second electrodes;

wherein the first electrodes are in closely spaced relation with the second electrodes on the proximal surface for engaging the tissue surface and applying an electric field;

a first power supply connected to the first electrode assembly for applying a pulsed electric field of sufficient amplitude to induce pores in the tissue surface; and

means for driving molecules through pores in the tissue surface.

13. The apparatus according to claim 12 wherein means for driving comprises:

a second electrode assembly spaced from the first electrode assembly and comprising at least one of an anode and a cathode; and

a second power supply connected to the first electrode assembly and the second electrode assembly for applying a low voltage continuous electric field of a preselected polarity and sufficient amplitude to induce migration of molecules through pores in the tissue surface.

14. The apparatus according to claim 12 wherein means for driving comprises a pressure source in communication with the tissue surface via the plurality of through holes in the carrier of the first electrode assembly for applying pressure of a sufficient amplitude and duration to induce migration of molecules through pores in the tissue surface.

15. The apparatus according to claim 12 wherein means for driving comprises an ultrasound source for applying ultrasound of a sufficient amplitude and duration to induce migration of molecules through pores in the tissue surface.

16. The apparatus according to claim 12 wherein means for driving comprises means for electroincorporation of molecules for applying electroincorporation of a sufficient amplitude and duration to induce migration of particles containing molecules through pores in the tissue surface.

17. The apparatus according to claim 12, wherein said first power supply and said second power supply comprising:

an electroporation power supply having a first contact and a second contact wherein a pulsed electric field of sufficient amplitude to induce pores in the tissue surface is applied;

an iontophoresis power supply having a first contact and a second contact wherein a low voltage continuous electric field of a preselected polarity and sufficient amplitude to induce migration of molecules through pores in the tissue surface is applied;

a first electrode assembly having a first contact and a second contact;

a second electrode assembly having a first contact and a second contact;

a first diode having an input connected to the first contact of the electroporation power supply and an output connected to the first contact of the first electrode assembly;

a second diode having an input connected to the first contact of the electroporation power supply and an output connected to the first contact of the second electrode assembly;

a third diode having an input connected to the second contact of the first electrode assembly and an output connected to the second contact of the electroporation power supply;

a fourth diode having an input connected to the second contact of the second electrode assembly and an output connected to the second contact of the electroporation power supply;

a fifth diode having an input connected to the first contact of the iontophoresis power supply and an output connected to the first contact of the first electrode assembly;

a sixth diode having an input connected to the first contact of the iontophoresis power supply and an output connected to the second contact of the first electrode assembly; and

a seventh diode having an input connected to the second contact of the second electrode assembly and an output connected to the second contact of the iontophoresis power supply.

18. A method of trans-surface molecular delivery, comprising:

providing a first electrode assembly, comprising:

a non-conductive carrier having a proximal surface, a distal surface, and a plurality of through holes from the proximal surface to the distal surface;

a first electrode disposed on at least a portion of the distal surface and extending through at least a portion of the plurality of through holes and onto at least a portion of the proximal surface; and

a second electrode disposed on at least a portion of the proximal surface and in closely spaced relation with the first electrode;

engaging a tissue surface with the first electrode assembly;

providing a first power supply connected to the first electrode assembly;

applying a pulsed electric field via the first electrode assembly of sufficient amplitude to induce pores in the tissue surface;

providing means for driving molecules through pores in the tissue surface; and

applying means for driving to induce migration of molecules through pores in the tissue surface.

19. The method according to claim 18 wherein the step of providing means for driving comprises the steps of:

providing a second electrode assembly spaced from the first electrode assembly and comprising at least one of an anode and a cathode; and

providing a second power supply connected to the first electrode assembly and the second electrode assembly,

and wherein the step of applying means for driving comprises the step of applying a low voltage continuous electric field of a preselected polarity and sufficient amplitude to induce migration of molecules through pores in the tissue surface.

20. The method according to claim 18 wherein the step of providing means for driving comprises the step of providing a pressure source in communication with the tissue

surface via the plurality of through holes in the carrier of the first electrode assembly and wherein the step of applying means for driving comprises the step of applying pressure to the first electrode assembly of a sufficient amplitude and duration to induce migration of molecules through pores in the tissue surface.

21. The method according to claim 18 wherein the step of providing means for driving comprises the step of providing an ultrasound source and wherein the step of applying means for driving comprises the step of applying ultrasound of a sufficient amplitude and duration to induce migration of molecules through pores in the tissue surface.

22. The method according to claim 18 wherein the step of providing means for driving comprises the step of providing means for electroincorporation of molecules and wherein the step of applying means for driving comprises the step of applying means for electroincorporation of a sufficient amplitude and duration to induce migration of particles containing molecules through pores in the tissue surface.

23. An apparatus for trans-surface molecular delivery, comprising:

an electroporation power supply having a first contact and a second contact wherein a pulsed electric field of sufficient amplitude to induce pores in the tissue surface is applied;

an iontophoresis power supply having a first contact and a second contact wherein a low voltage continuous electric field of a preselected polarity and sufficient amplitude to induce migration of molecules through pores in the tissue surface is applied;

a first electrode assembly having a first contact and a second contact;

a second electrode assembly having a first contact and a second contact;

a first diode having an input connected to the first contact of the electroporation power supply and an output connected to the first contact of the first electrode assembly;

a second diode having an input connected to the first contact of the electroporation power supply and an output connected to the first contact of the second electrode assembly;

a third diode having an input connected to the second contact of the first electrode assembly and an output connected to the second contact of the electroporation power supply;

a fourth diode having an input connected to the second contact of the second electrode assembly and an output connected to the second contact of the electroporation power supply;

a fifth diode having an input connected to the first contact of the iontophoresis power supply and an output connected to the first contact of the first electrode assembly;

a sixth diode having an input connected to the first contact of the iontophoresis power supply and an output connected to the second contact of the first electrode assembly; and

a seventh diode having an input connected to the second contact of the second electrode assembly and an output connected to the second contact of the iontophoresis power supply.